

WHAT IS CLAIMED IS:

1. Apparatus for extracting a substance from a liquid sample comprising:

5 a) a container having an entrance, an exit, and a passage therebetween for passage of a liquid sample containing a substance to be extracted therethrough;

b) within the passage, a thin layer of microparticulate extraction media for extracting the substance from the liquid sample, wherein:

10 (i) the extraction media layer has a top surface, a bottom surface, and a peripheral edge,

(ii) the extraction media has a particle size of less than 20 microns,

15 (iii) the ratio of the effective diameter of the extraction media layer to the distance between its top and bottom surfaces is at least 5, and

(iv) the extraction media layer is oriented in the passage so that liquid flows through the extraction media layer from its top surface to the bottom surface; and

20 c) an upper compression layer at the top surface of the extraction media layer and a lower compression layer at the lower surface of the extraction media layer, the two compression layers pressing the extraction media therebetween, the compression layers being sufficiently porous that the liquid sample flows therethrough, the compression layers being formed of a flexible, hydrophilic, microfiber material and having a pore size less than the particle size of the extraction media.

2. The apparatus of claim 1 wherein the apparatus is made of materials substantially inert to biological fluids so that when blood or urine is passed through the apparatus, substantially nothing passes from the apparatus into the blood or urine.

3. The apparatus of claim 1 wherein the distance between the top and bottom surfaces of the layer of extraction media is less than 1 mm.

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4. The apparatus of claim 3 wherein the the distance between the top and bottom surfaces of the layer of extraction media is from 0.2 to 0.9 mm.

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5. The apparatus of claim 1 wherein the compression layers are formed of the same material.

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6. The apparatus of claim 1 including an upper mesh flow distributor above the upper compression layer for distributing flow of the liquid sample uniformly to the extraction media layer top surface.

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7. The apparatus of claim 1 wherein the upper mesh flow distributor holds the compression layers and the extraction media layer in the container.

8. The apparatus of claim 1 including a lower mesh flow distributor below the lower compression layer.

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9. The apparatus of claim 1 wherein the container has a bottom with the exit being in the bottom, the bottom having an internal wall, the internal wall being substantially flat.

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10. The apparatus of claim 9 wherein the exit is substantially centrally located in the bottom.

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11. The apparatus of claim 1 wherein the container includes an inner wall in contact with the peripheral edge of the media layer.

12. Apparatus for extracting an analyte from a liquid sample comprising:

a) a microcolumn having an entrance, an opposed exit, and a passage for passage of the liquid sample downwardly therethrough;

b) within the passage, a thin layer of microparticulate silica extraction media for the analyte, wherein:

(i) the extraction media layer has a top surface, a bottom surface, and a peripheral edge,

(ii) the extraction media has a particle size of less than 20 microns,

(iii) the ratio of the effective diameter of the extraction media layer to the thickness of the extraction media layer is at least 5, and

(iv) the extraction media layer is oriented in the passage so that liquid flows through the layer from its top surface to the bottom surface;

c) an upper compression layer at the top surface of the extraction media layer and a lower compression layer at the lower surface of the extraction media layer, the compression layers pressing the silica extraction media therebetween, the compression layers being sufficiently porous that the liquid sample flows therethrough, the compression layers being formed of a flexible, hydrophilic, glass fiber and having a pore size less than the particle size of the silica extraction media;

d) an upper mesh flow distributor above the upper compression layer for distributing flow of the liquid sample uniformly to the extraction media layer top surface; and

e) a lower mesh flow distributor below the lower compression layer.

13. The apparatus of claim 12 wherein the pore size of the compression layer is less than 5 microns.

14. The apparatus of claim 12 wherein the microcolumn has a bottom with the exit being through the bottom, the bottom having an internal wall, the internal wall being substantially flat.

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15. The apparatus of claim 14 wherein the exit is substantially centrally located in the bottom.

16. Apparatus for extracting an analyte from a liquid sample comprising:

10 a) a microcolumn having an entrance, an opposed exit, an inner peripheral wall, a substantially flat inner bottom wall, and a central bore therethrough for passage of a liquid sample containing an analyte
15 therethrough, the exit being substantially centrally located in the bottom wall;

b) within the bore, a thin layer of microparticulate silica extraction media adapted for extracting the analyte from the liquid sample, the
20 extraction media having a particle size of less than 20 microns, the extraction media having a top surface facing the entrance and a bottom surface facing the exit, the ratio of the diameter of the extraction media layer to the thickness of the layer being at least 10, the inner
25 wall of the microcolumn being in contact with the peripheral edge of the extraction media layer;

c) an upper compression layer and a lower compression layer pressing the silica extraction media therebetween, the compression layers being sufficiently
30 porous that the liquid sample flows therethrough and into the extraction media layer top surface and out of the extraction media layer bottom surface, the compression layers being formed of a flexible, hydrophilic, substantially binder free glass fiber and having a pore
35 size less than the particle size of the silica extraction media; and

d) an upper mesh flow distributor above the upper compression layer and a lower mesh flow distributor below the lower compression layer sandwiching the compression layers and the layer of extraction media therebetween, the flow distributors holding the extraction media and the compression layers in the microcolumn, the upper compression layer distributing liquid sample uniformly across the top surface of the extraction media layer.

17. Apparatus for extracting an analyte from a liquid sample comprising:

a) a container having an entrance, an exit, and a passage therebetween for passage of a liquid sample containing an analyte therethrough, the container having a substantially flat bottom wall with the exit substantially centrally located therein;

b) within the passage, a thin layer of microparticulate extraction media for extracting the analyte from the liquid sample, wherein:

(i) the extraction media layer has a top surface, a bottom surface, and a peripheral edge,

(ii) the extraction media has a particle size of less than 20 microns,

(iii) the distance between the top and bottom surfaces of the extraction media layer is less than 1 mm, and

(iv) the extraction media layer is oriented in the passage so that liquid flows through the layer from its top surface to the bottom surface;

c) an upper compression layer at the top surface of the extraction media layer and a lower compression layer at the lower surface of the extraction media layer, the two compression layers pressing the extraction media therebetween, the compression layers being sufficiently porous that the liquid sample can flow therethrough, the compression layers being formed of a

flexible, hydrophilic, microfiber material and having a pore size less than the particle size of the extraction media;

5 d) an upper mesh flow distributor above the upper compression layer for distributing flow of the liquid sample uniformly to the extraction media layer top surface; and

e) a lower mesh flow distributor below the lower compression layer.

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18. The apparatus of claim 17 including an upper mesh flow distributor above the upper compression layer for distributing flow of the liquid sample through the extraction media.

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19. The apparatus of claim 18 wherein the upper mesh flow distributor holds the compression layers and the extraction media layer in the microcolumn.

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20. The apparatus of claim 18 including a lower mesh flow distributor below the lower compression layer.

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21. A method of extracting a substance from a liquid sample comprising the step of passing the liquid sample into the entrance of the apparatus of claim 1 for transverse flow through the extraction media layer and out the exit, wherein the substance is extracted from the liquid sample by the extraction media.

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22. A method of extracting an analyte from a liquid sample comprising the step of passing the liquid sample into the entrance of the apparatus of claim 12 for transverse flow through the extraction media layer and out the exit, wherein the analyte is extracted from the liquid sample by the extraction media.

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23. A method of extracting an analyte from a liquid sample comprising the step of passing the liquid sample into the entrance of the apparatus of claim 16 for transverse flow through the extraction media layer and
5 out the exit, wherein the analyte is extracted from the liquid sample by the extraction media.

24. A method of extracting an analyte from a liquid sample comprising the step of passing the liquid
10 sample into the entrance of the apparatus of claim 17 for transverse flow through the extraction media layer and out the exit, wherein the analyte is extracted from the liquid sample by the extraction media.

25. The apparatus of claim 1 wherein the ratio of the effective diameter of the extraction media layer to the distance between its top and bottom surfaces is at
15 least 10.

26. Apparatus for extracting a substance from a liquid sample comprising:

(a) a container having a top, a bottom, an entrance in the top, an exit in the bottom, and a passage between the entrance and exit for downward passage of a
25 liquid sample therethrough, the bottom having an inner wall which is substantially flat with the exit being substantially centrally located in the bottom; and

(b) within the passage, a thin layer of microparticulate extraction media for extraction of the
30 substance from the liquid sample.